Evaluation of EPA Vehicle Fleet Age Distribution Projection Tool

Jin-Sheng Lin, Kristen Stumpf, and Sonya Lewis-Cheatham
Virginia Department of Environmental Quality

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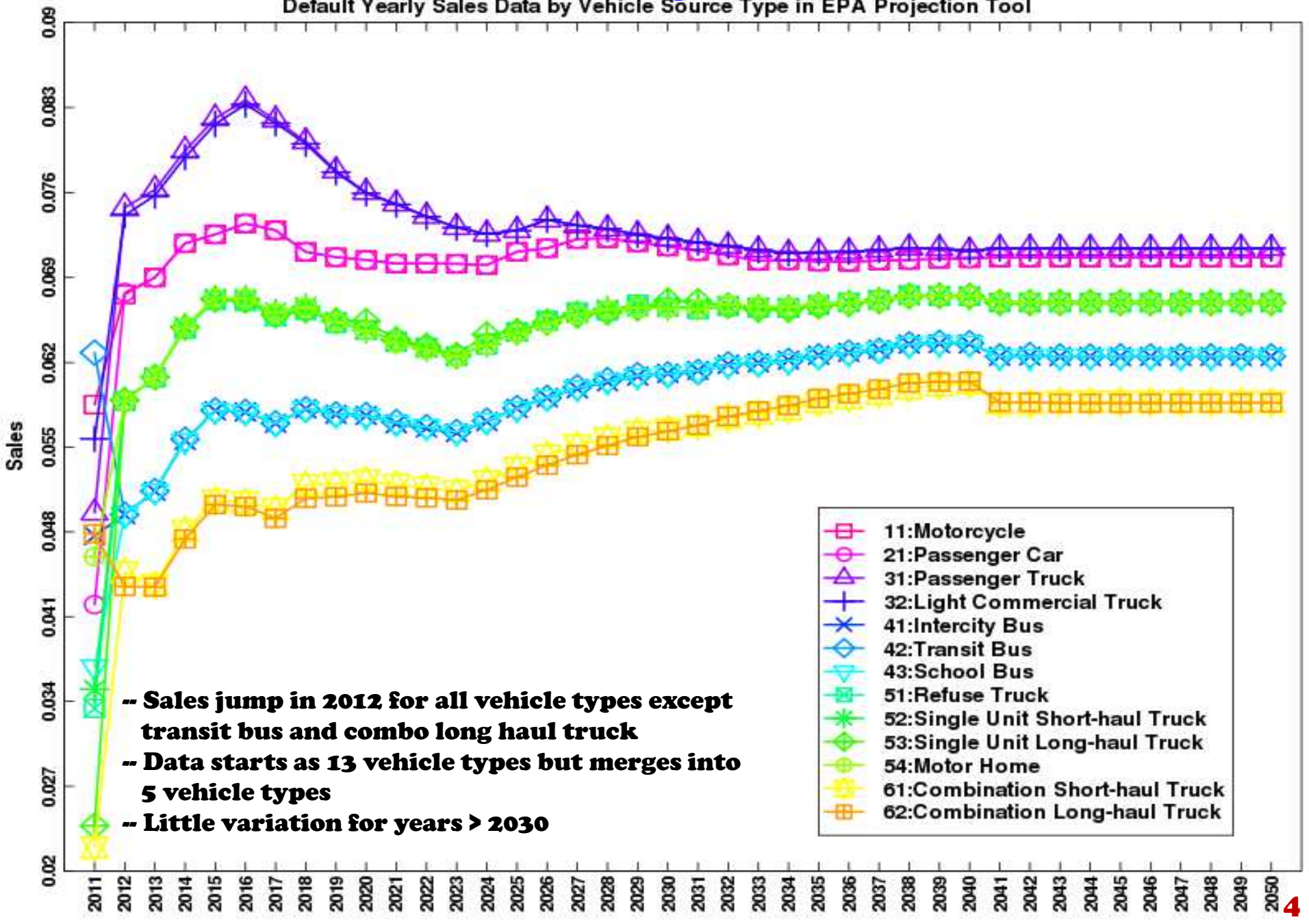
Approach

- Examine Excel macro in EPA projection tool
- Translate the tool in Excel to scripting language in perl
  - so that counties/future years of interest can be calculated in batch
- Compare age distribution projected by the VADEQ tool in perl with:
  - sample outputs obtained from the EPA tool
  - fleet ages in 2018 CDBs posted by EPA
- Conduct CONUS scale projections
- Understand the projection tool

EPA Age Distribution Projection Tool

- Age 0 fraction in future years is equal to vehicle sales
- Age 30 fraction in future years is equal to the base year
- Every intermediate year fraction (age 1 – age 29) is based on the scrappage of the previous year
- Intermediate table (for age 1 – age 29):
  - 2012_age1_intermediate = 2011_age0_fraction * (1 – scrappage_Kfactor_2011 * scrappage_age0)
- Future year projection is based on intermediate table:
  - 2012_age1_fraction = 2012_age1_intermediate * (1 – sales_2012 – 2012_age30_fraction) / sum (2012_age1_intermediate:2012_age29_intermediate)

Sales Data – Age 0 Fraction

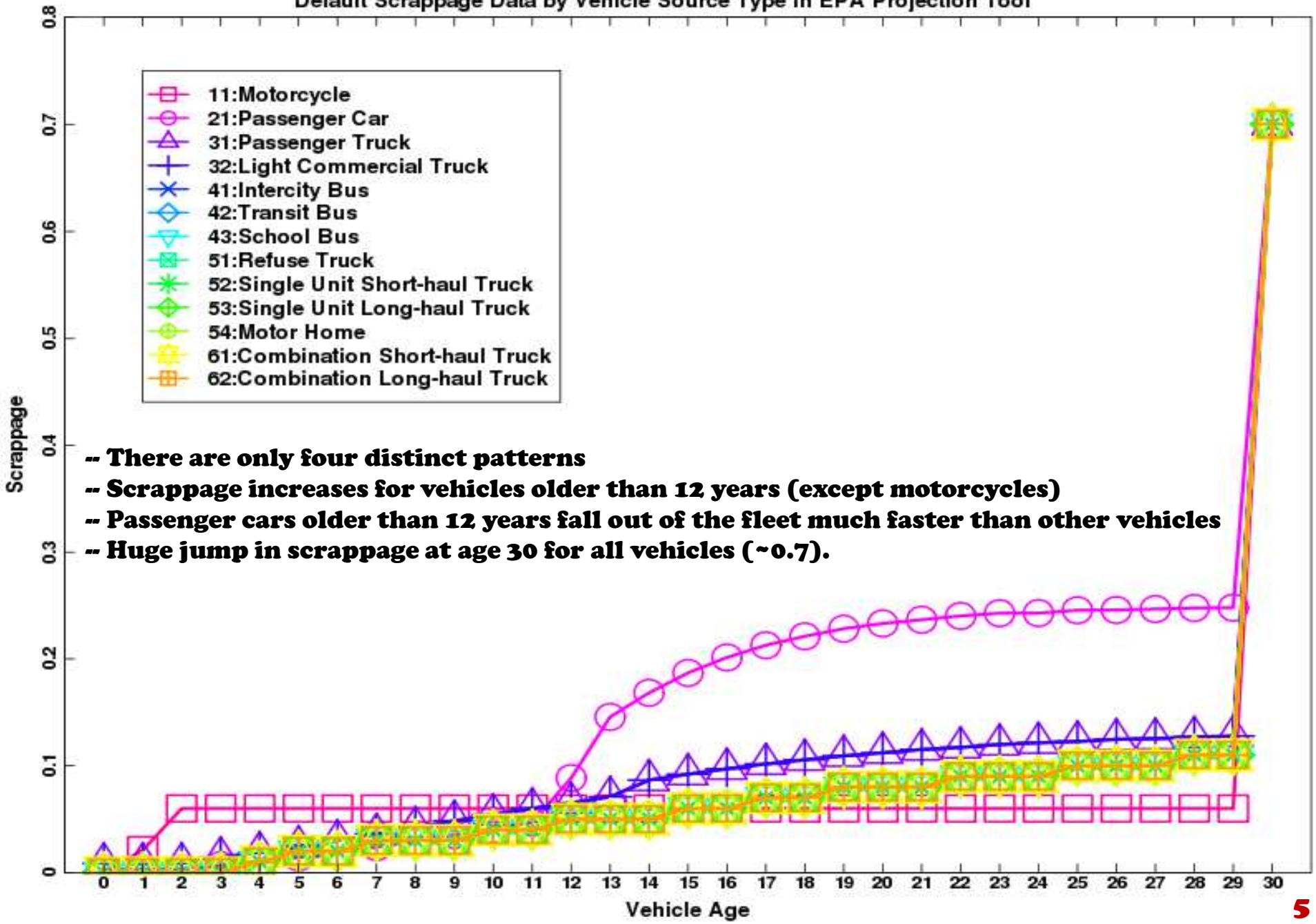


-- Sales jump in 2012 for all vehicle types except transit bus and combo long haul truck

-- Data starts as 13 vehicle types but merges into 5 vehicle types

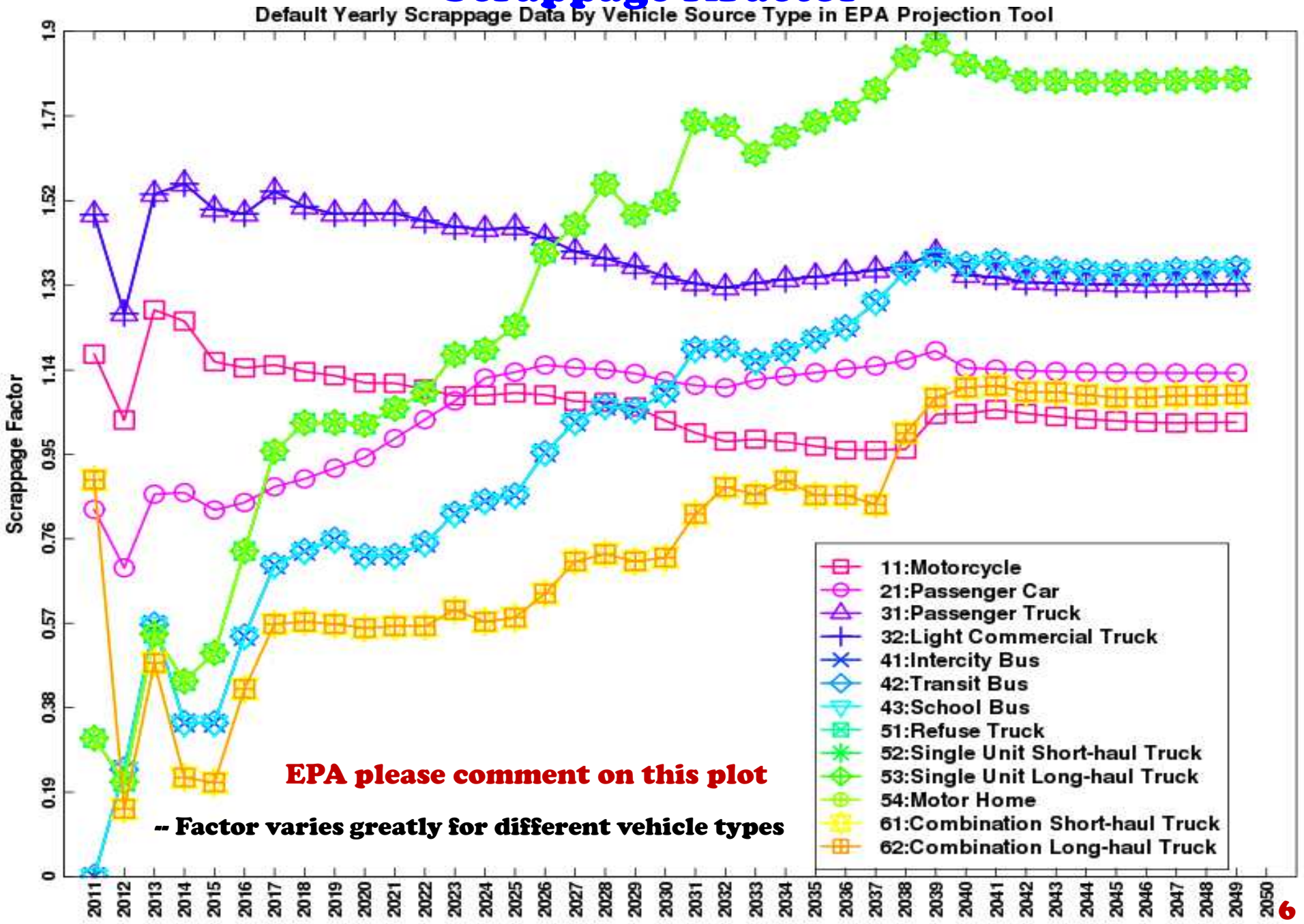
-- Little variation for years > 2030

Scrappage Data



-- There are only four distinct patterns
-- Scrappage increases for vehicles older than 12 years (except motorcycles)
-- Passenger cars older than 12 years fall out of the fleet much faster than other vehicles
-- Huge jump in scrappage at age 30 for all vehicles (~0.7).

Scrappage KFactor

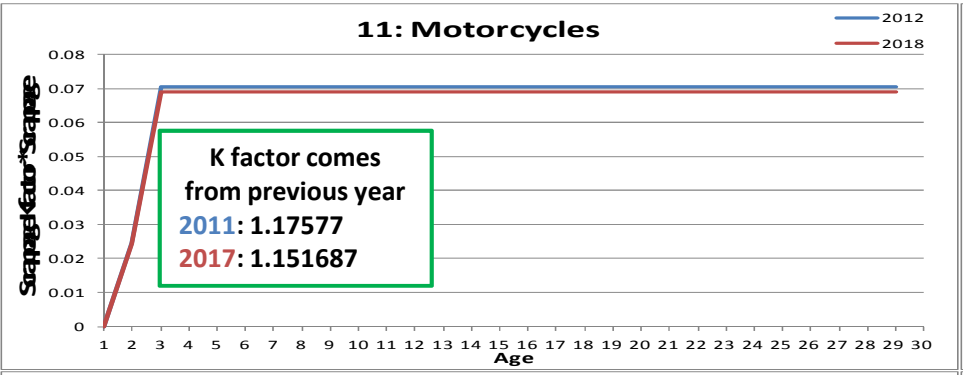


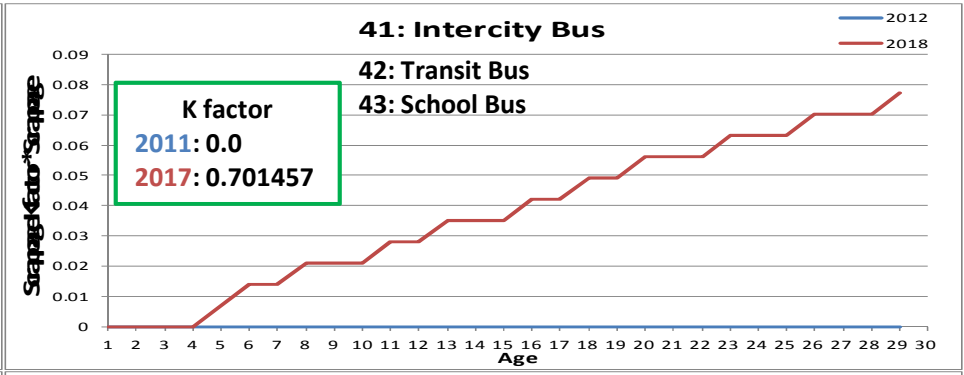
Scrappage * Scrappage K Factor

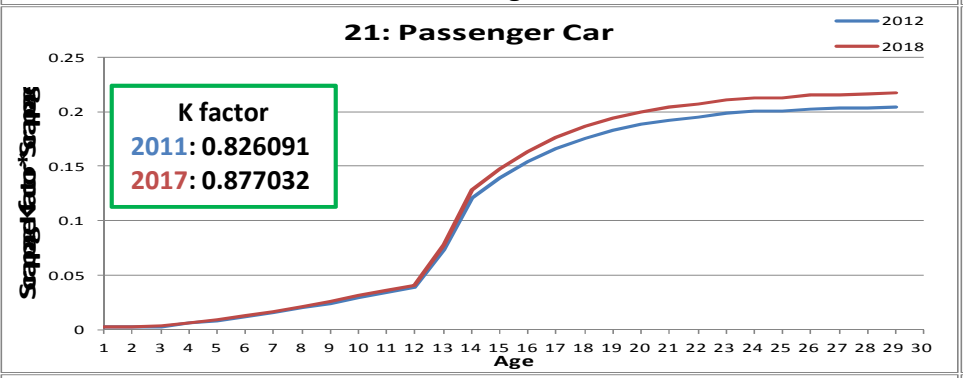
example: 2012 and 2018

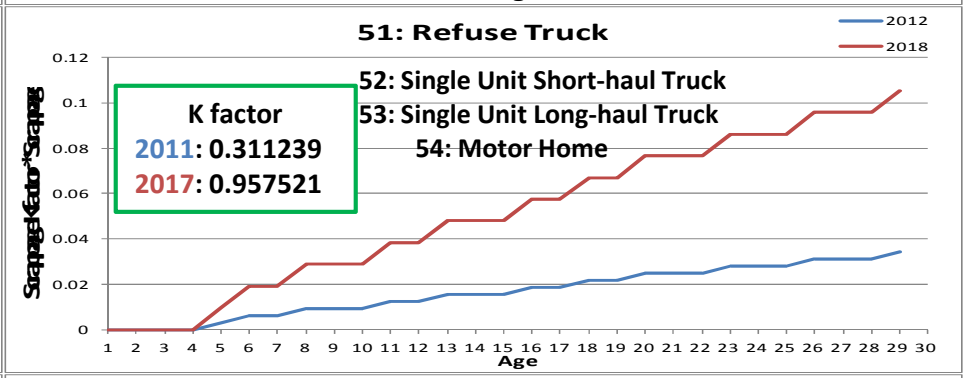
- (Scrappage * Scrappage KFactor) is how the two variables are used in the Projection Tool
- Represents the percentage of vehicles scrapped (removed from the fleet) from each age bin in the given year
- 2012 was chosen as an example because K factor of previous year is needed and 2011 would require 2010 K factor, which is not available in the Projection Tool (i.e., data begins at 2011)
- Shape follows that of scrappage, with adjustment by K factor
  - Higher K factor results in higher scrappage rate

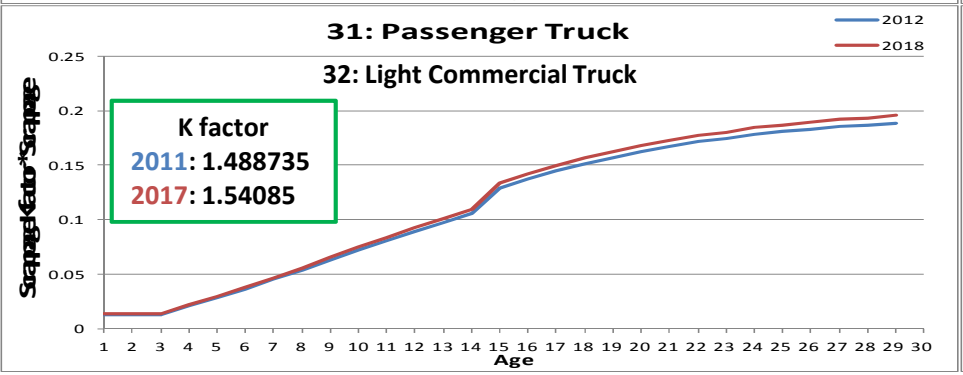
(Scrappage * Scrappage K Factor) for 2012 and 2018

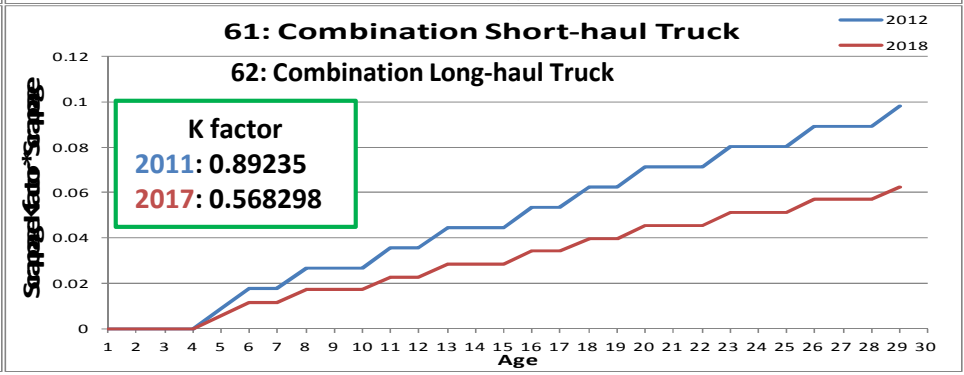








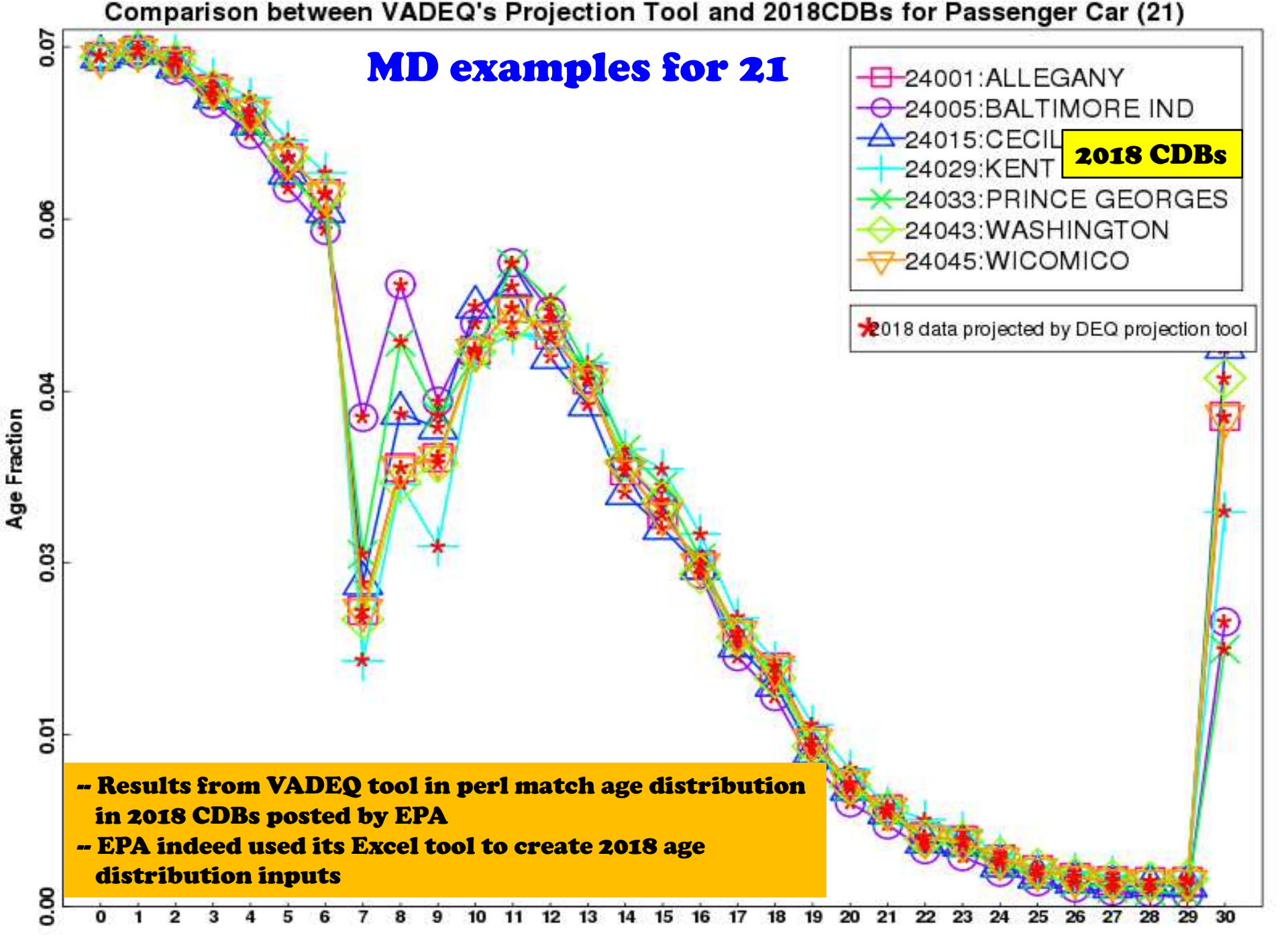


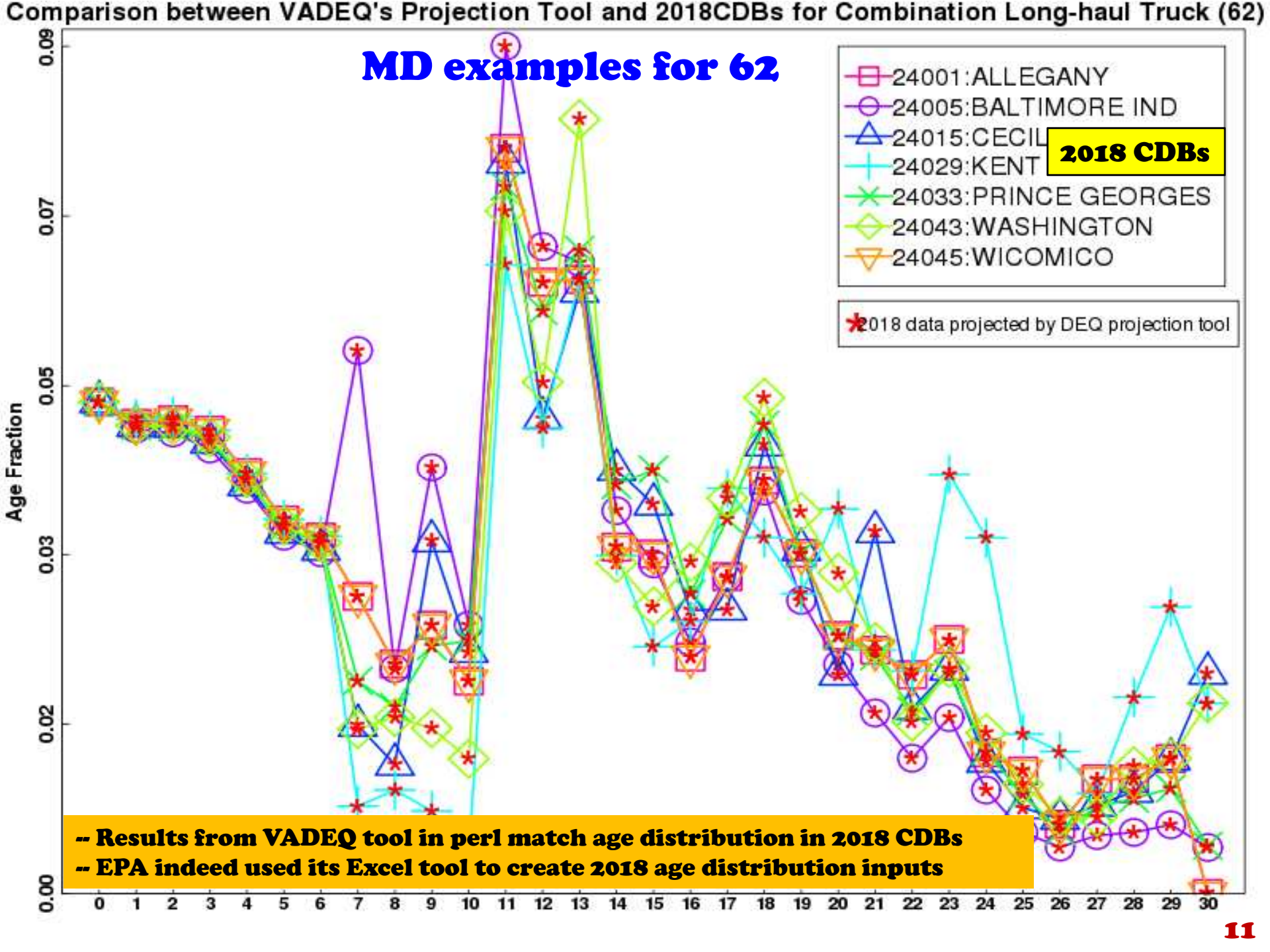


- **For passenger cars and light commercial trucks, older vehicles will be removed from the fleet at a higher rate in 2018 than 2012 (see also page 21)**
- **For motorcycles and combo trucks, older vehicles will be removed at a lower rate in 2018 than 2012 (see also page 22)**

EPA Age Distribution Projection Tool

- **Inputs:**
  - **base year age distribution**
  - **Sales data (tool default)**
  - **Scrappage and its K factor (tool default)**
- **Projection varies by 13 MOVES vehicle types**
- **Future year projection depends on all previous years. For example, 2018 is based on 2017, 2017 is based on 2016, etc. In other words, intermediate years from base year to future year all must be calculated in order to obtain projected age distribution for the future year of interest**


Comparison between VADEQ's Projection Tool and 2018CDBs for Passenger Car (21)
MD examples for 21
24001:ALLEGANY
24005:BALTIMORE IND
24015:CECIL
24029:KENT
24033:PRINCE GEORGES
24043:WASHINGTON
24045:WICOMICO
2018 CDBs
2018 data projected by DEQ projection tool
Age Fraction
0.00
0.01
0.03
0.04
0.06
0.07
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
-- Results from VADEQ tool in perl match age distribution in 2018 CDBs posted by EPA
-- EPA indeed used its Excel tool to create 2018 age distribution inputs


Comparison between VADEQ's Projection Tool and 2018CDBs for Combination Long-haul Truck (62)
MD examples for 62
24001:ALLEGANY
24005:BALTIMORE IND
24015:CECIL
24029:KENT
24033:PRINCE GEORGES
24043:WASHINGTON
24045:WICOMICO
2018 CDBs
2018 data projected by DEQ projection tool
Age Fraction
0.00
0.02
0.03
0.05
0.07
0.09
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
-- Results from VADEQ tool in perl match age distribution in 2018 CDBs
-- EPA indeed used its Excel tool to create 2018 age distribution inputs

Age Distribution Projection by VADEQ Tool

Projections vary by county and by vehicle type

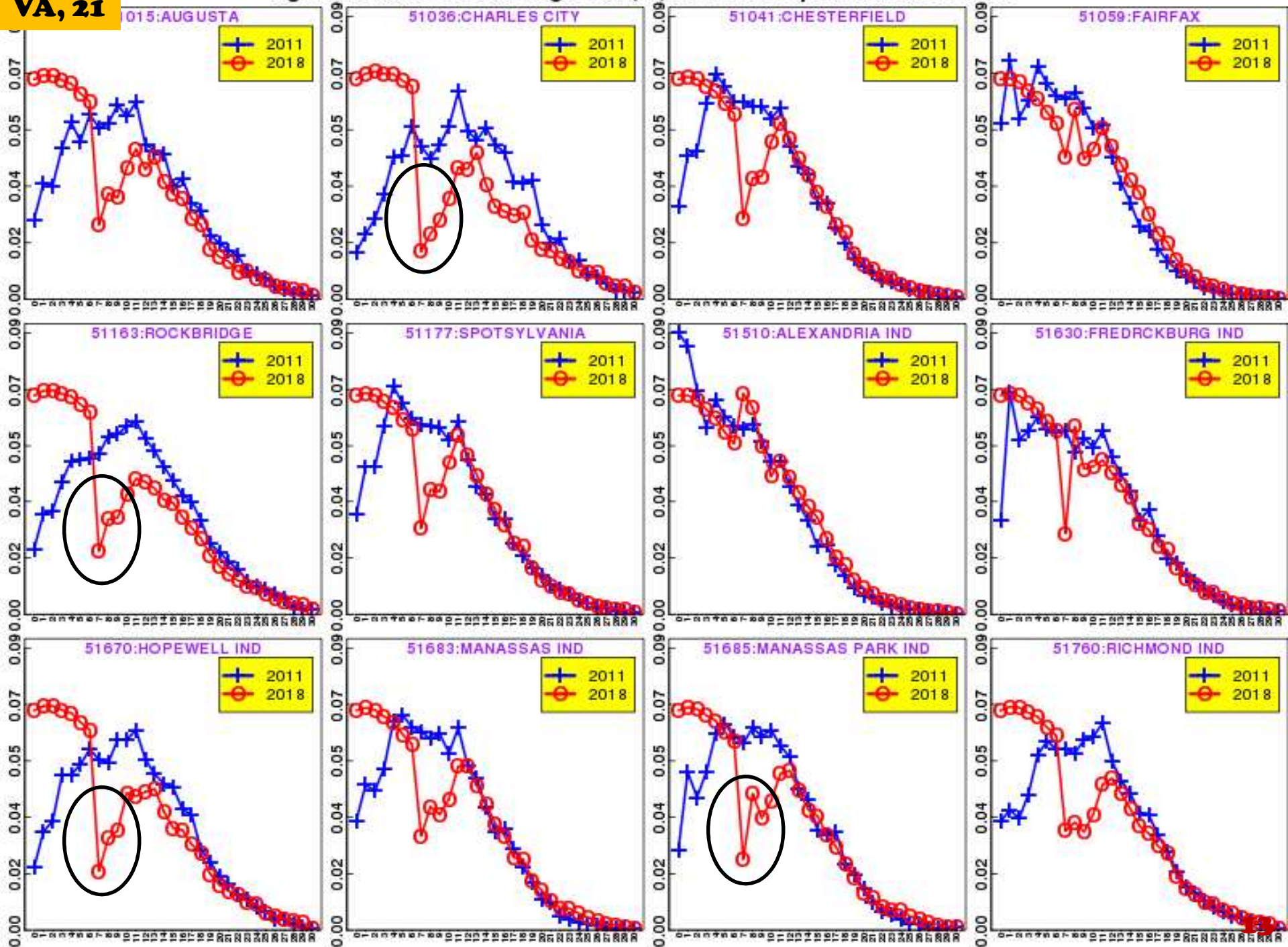
2011 (in blue):
- base year fleet age distribution from 2011 (representative county) CDBs

2018 (in red):
- fleet age distribution projection by VADEQ tool

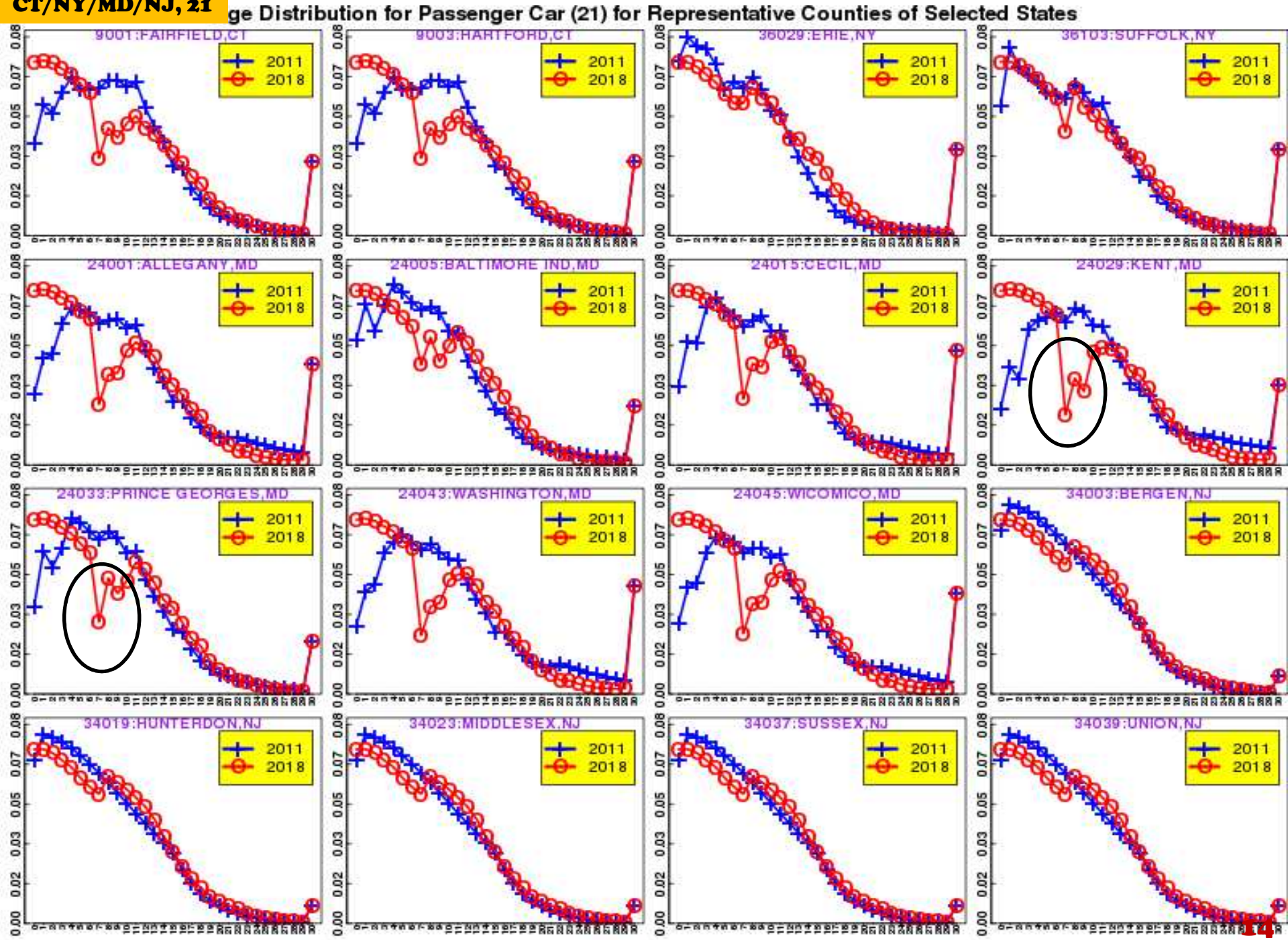
2011 Michigan age distributions contained zero fraction for some age bins or vehicle types which caused errors in both the EPA and VADEQ projection tools (illegal division by zero).

VA, 21

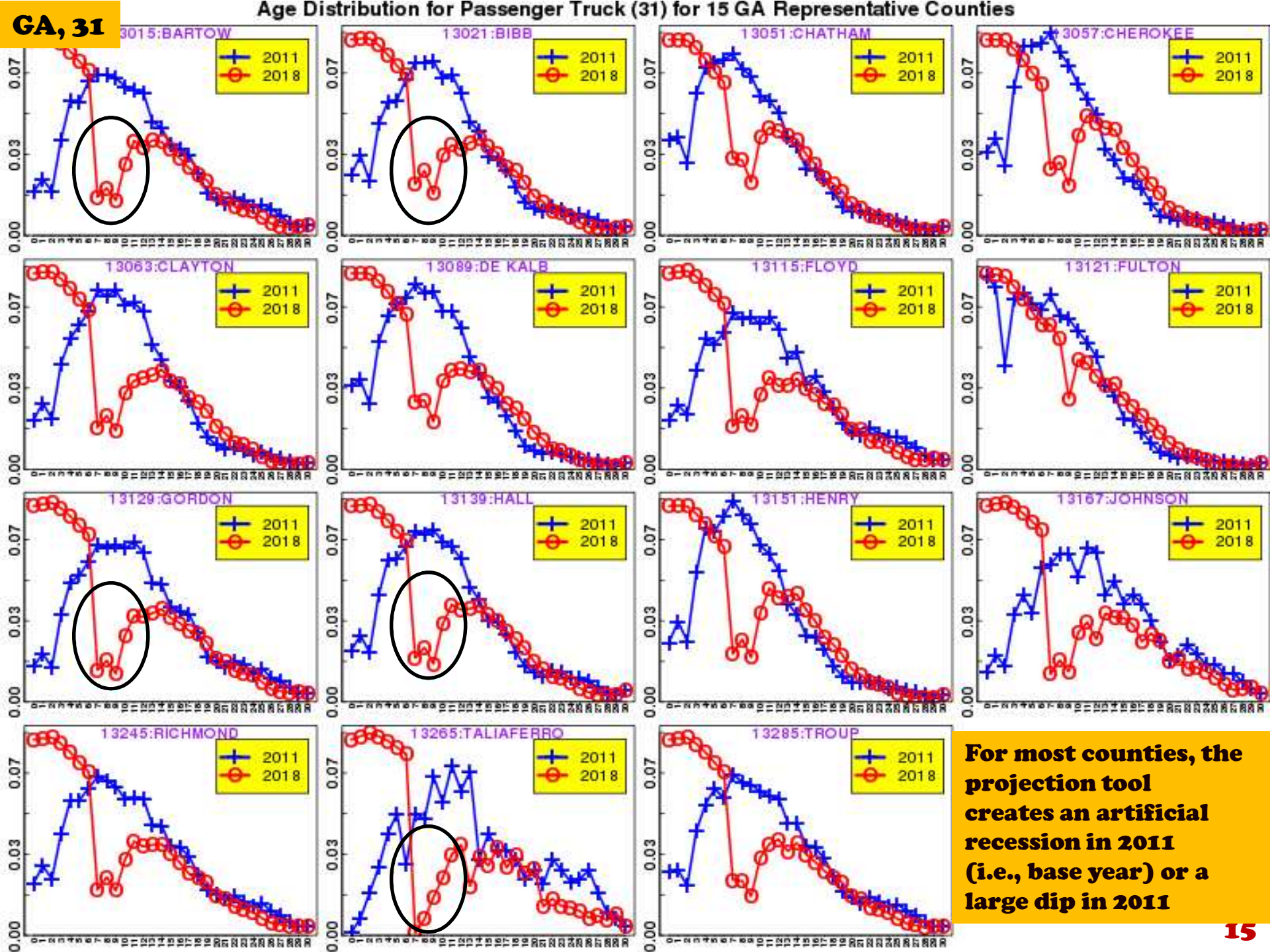
Age Distribution for Passenger Car (21) for 12 VA Representative Counties



CT/NY/MD/NJ, 21


ge Distribution for Passenger Car (21) for Representative Counties of Selected States
9001:FAIRFIELD,CT
9003:HARTFORD,CT
36029:ERIE,NY
36103:SUFFOLK,NY
24001:ALLEGANY,MD
24005:BALTIMORE IND,MD
24015:CECIL,MD
24029:KENT,MD
24033:PRINCE GEORGES,MD
24043:WASHINGTON,MD
24045:WICOMICO,MD
34003:BERGEN,NJ
34019:HUNTERDON,NJ
34023:MIDDLESEX,NJ
34037:SUSSEX,NJ
34039:UNION,NJ
2011
2018

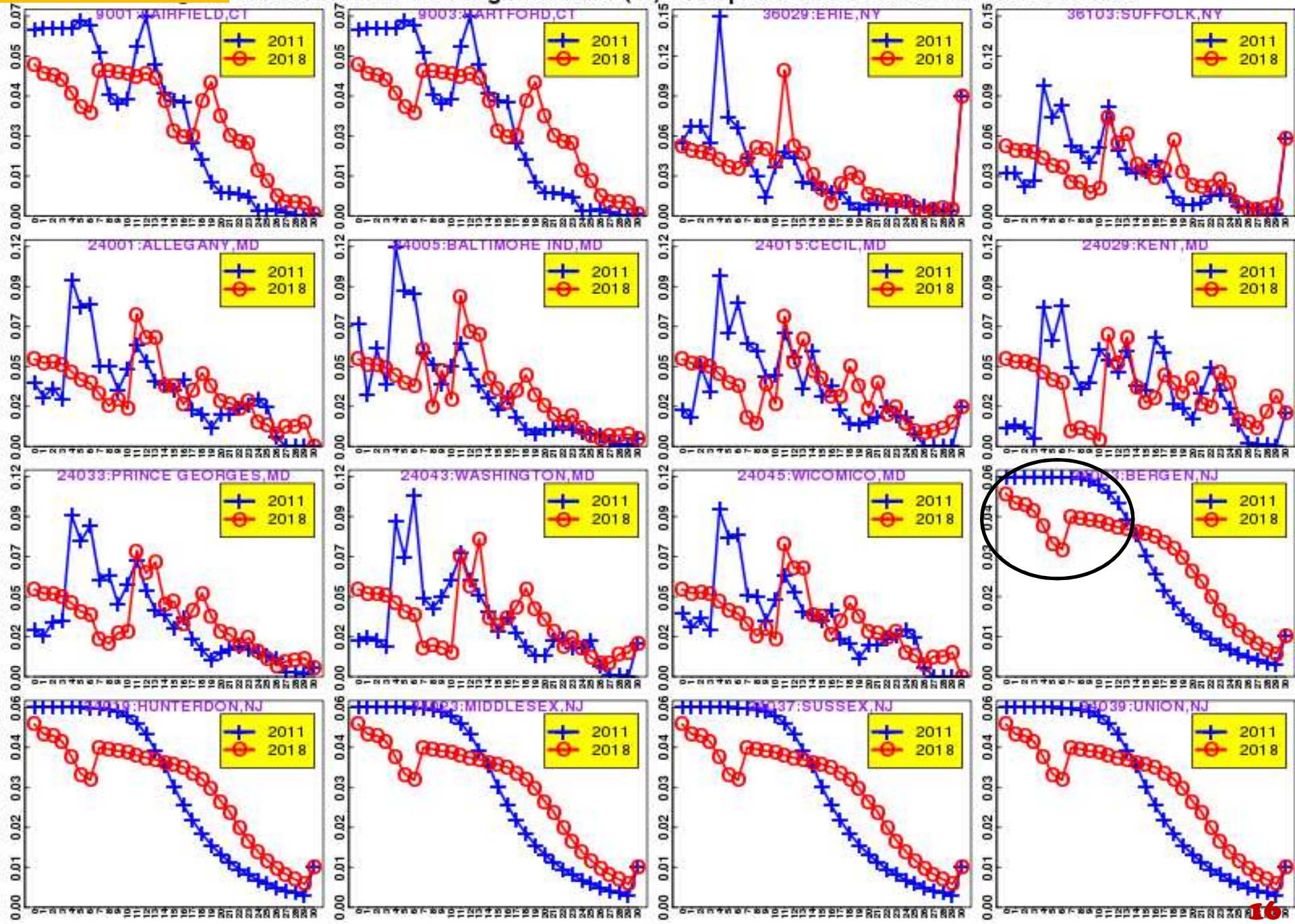
GA, 31



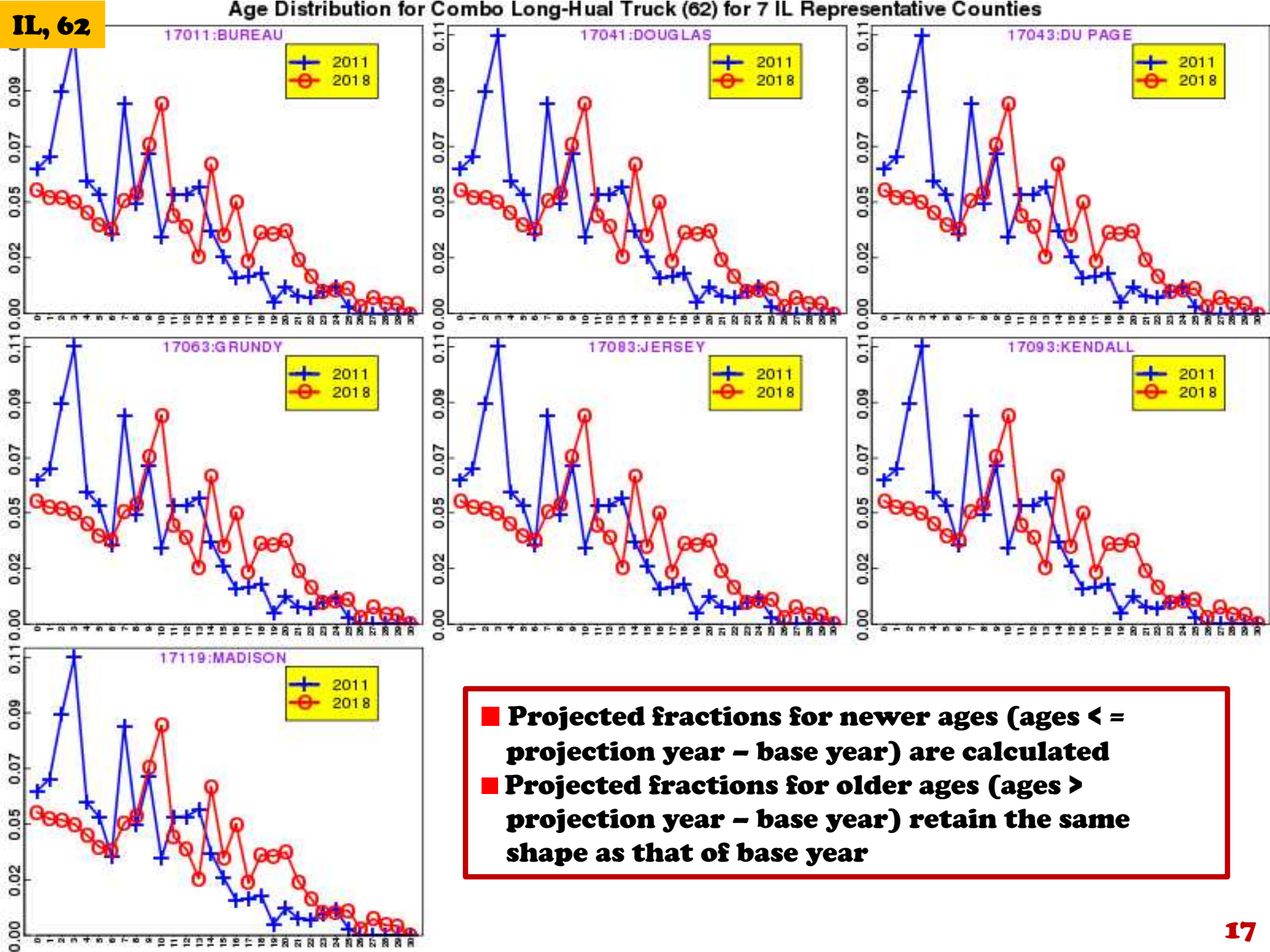
For most counties, the projection tool creates an artificial recession in 2011 (i.e., base year) or a large dip in 2011

CT/NY/MD/NJ, 62

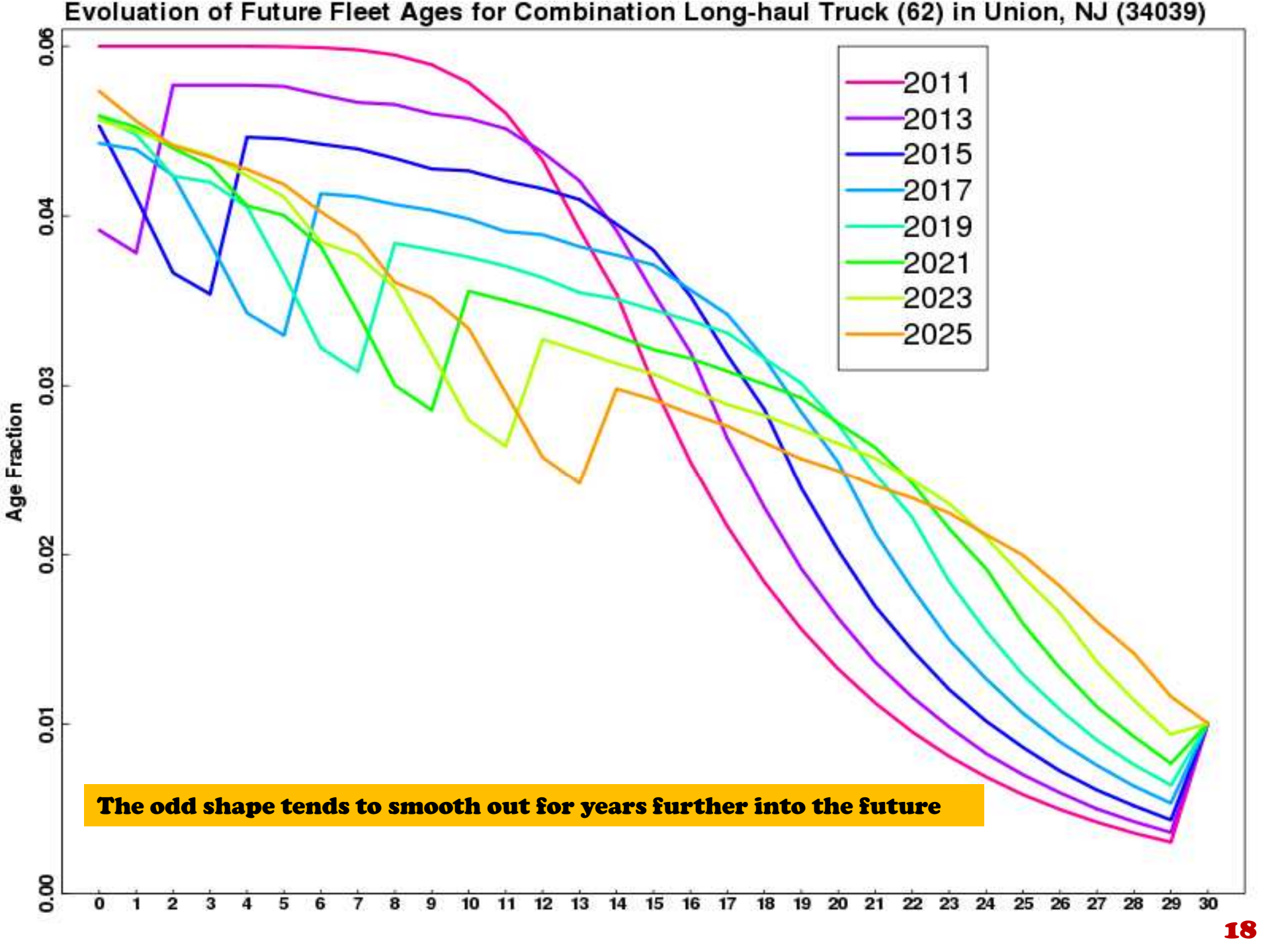
stribution for Combo Long-Haul Truck (62) for Representative Counties of Selected States

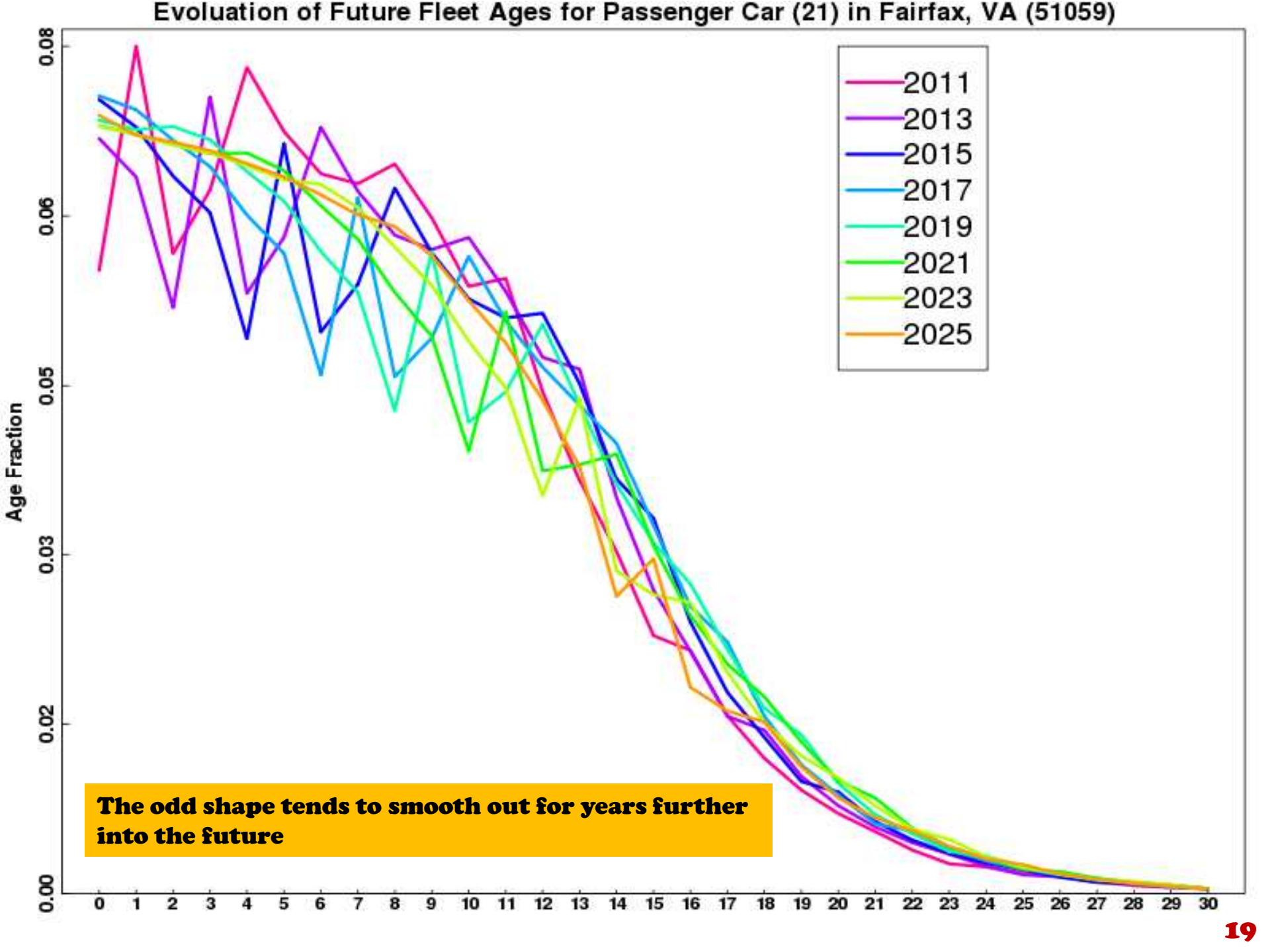


IL, 62



- **Projected fractions for newer ages (ages < = projection year – base year) are calculated**
- **Projected fractions for older ages (ages > projection year – base year) retain the same shape as that of base year**


Evoluation of Future Fleet Ages for Combination Long-haul Truck (62) in Union, NJ (34039)
Age Fraction
0.00
0.01
0.02
0.03
0.04
0.06
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
2011
2013
2015
2017
2019
2021
2023
2025
The odd shape tends to smooth out for years further into the future


Evoluation of Future Fleet Ages for Passenger Car (21) in Fairfax, VA (51059)
Age Fraction
0.00
0.02
0.03
0.05
0.06
0.08
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
2011
2013
2015
2017
2019
2021
2023
2025
The odd shape tends to smooth out for years further into the future

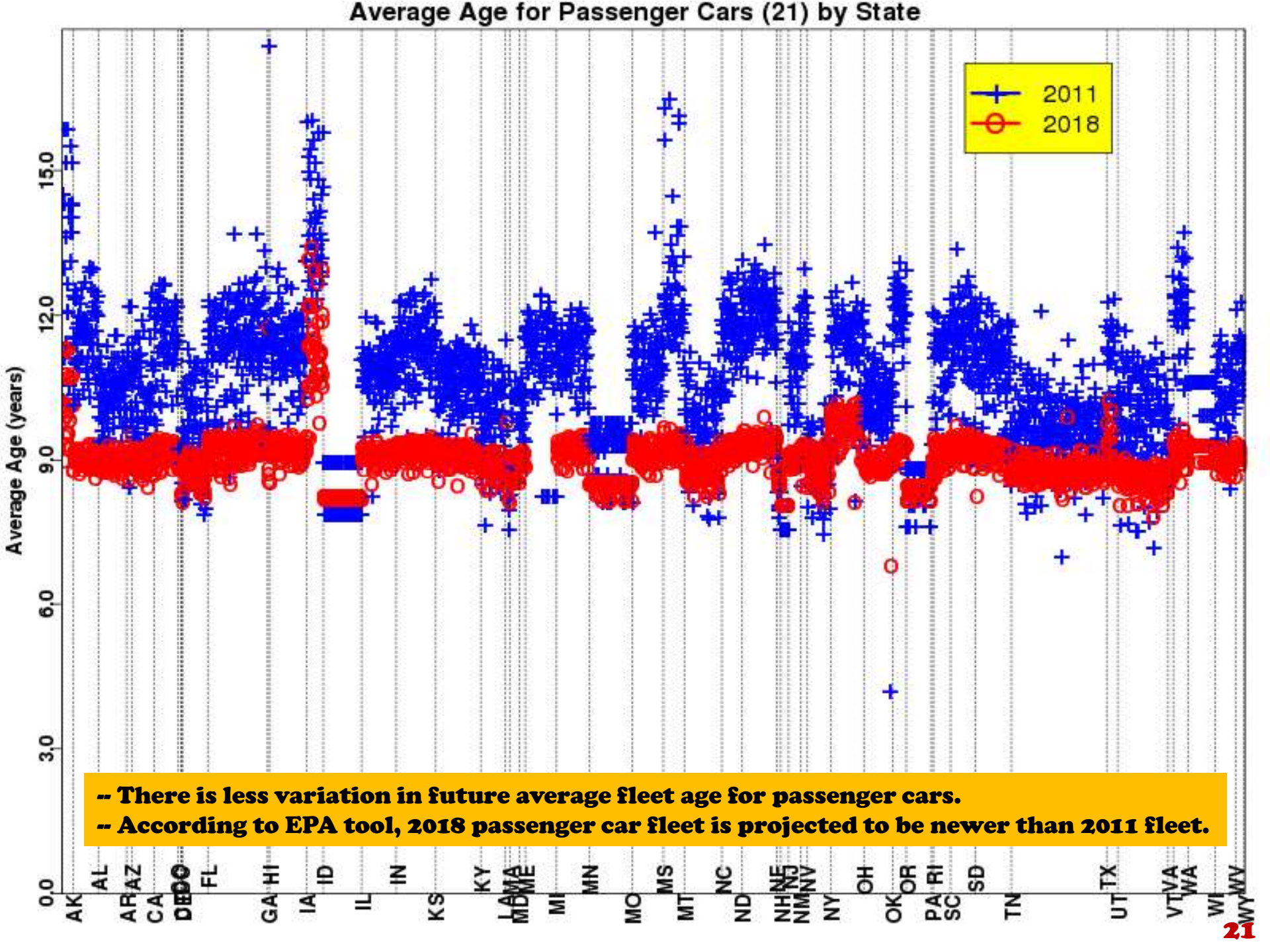
Change in Average Fleet Age

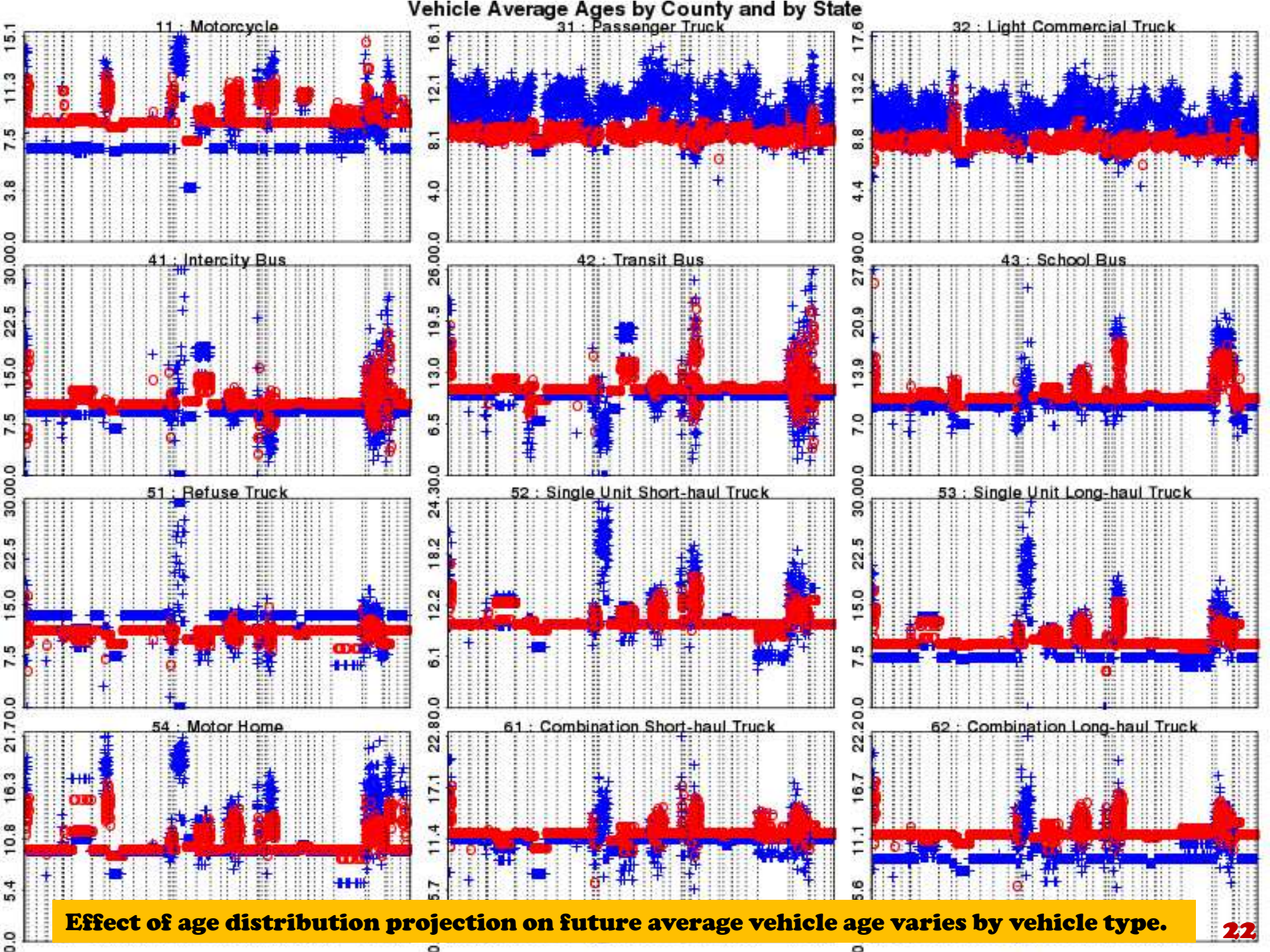
Comparison of average fleet age based on 2011 age distribution versus 2018 projected age distribution

Projections vary by county and by vehicle type

2011 (in blue):
- average age based on age distributions from 2011 (individual county) CDBs

2018 (in red):
- average age based on age distributions from VADEQ projection tool


Average Age for Passenger Cars (21) by State
2011
2018
Average Age (years)
0.0
3.0
6.0
9.0
12.0
15.0
AK
AL
AR
AZ
CA
FL
GA
HI
IA
ID
IL
IN
KS
KY
MA
MD
ME
MI
MN
MO
MS
MT
NC
ND
NE
NH
NJ
NM
NV
NY
OH
OK
OR
PA
RI
SC
SD
TN
TX
UT
VA
VT
WA
WI
WV
WY
-- There is less variation in future average fleet age for passenger cars.
-- According to EPA tool, 2018 passenger car fleet is projected to be newer than 2011 fleet.



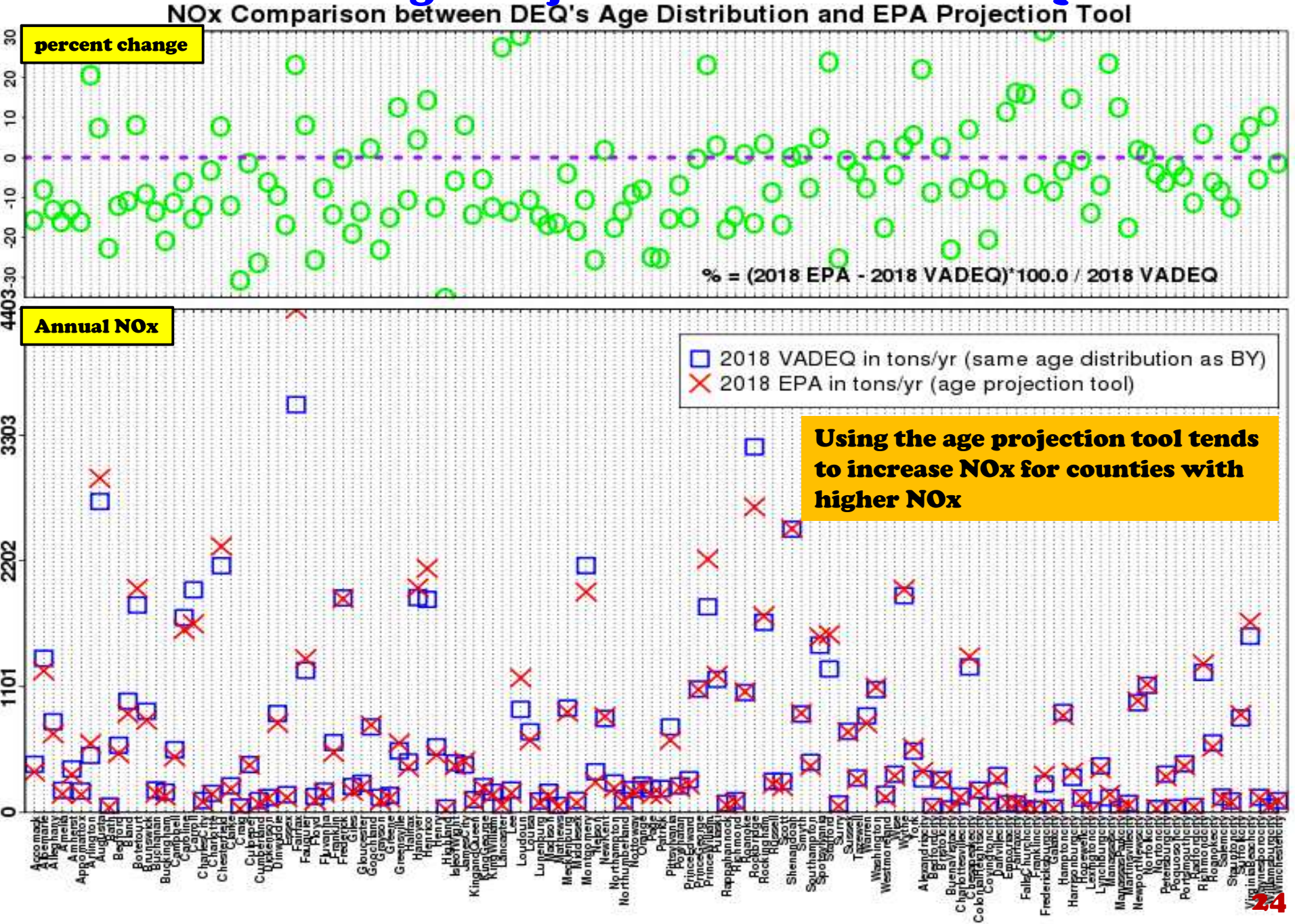
Effect of age distribution projection on future average vehicle age varies by vehicle type.

Effect of Age Projection Tool – VA Example

Model Setup

- MOVES runs in inventory mode for VA 134 counties
- Year examined: 2018
- **Control run**: age distributions identical to those of 2011 base year
- **Sensitivity run**: age distributions projected by the EPA age projection tool
- All other inputs identical between the two runs
- Examine NOx differences

Effect of Age Projection Tool – VA Example



Summary

- The age distribution projection tool assumes the future year fleet age profile is different from the base year fleet
- Passenger cars/trucks and refuse trucks are projected to have an overall **newer** fleet compared to the base year
- Single unit/combination trucks, motorcycles, and buses are projected to have an overall **older** fleet compared to the base year
- All else being equal, future emissions may increase or decrease from base year, depending on the vehicle makeup in the base year data
- The projection tool makes combination long haul trucks (an already dominating category in base year) even more dominating in future years

Summary (cont.)

- Future year fleet average age becomes more homogeneous across the nation, especially for light duty vehicles
- Odd profile tends to smooth out for years further into the future. Age 30 fraction, which is the same as base year, could be exaggerated/magnified as a result
- States and regional organizations increasingly rely on NEI emissions for SIP and other planning activities
- Since the NEI uses different age distributions for base and future years, emission changes in sensitivity modeling cannot be attributed entirely to control measures

Presentations Archive

Repository for VADEQ presentations on MOVES and SMOKE-MOVES:

http://www.deq.virginia.gov/Programs/Air/AirQualityAssessments/PhotochemicalModeling/DEQPresentationsonMOVES.aspx

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